

FORM PTO-1390  
(REV. 11-2000)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

**TRANSMITTAL LETTER TO THE UNITED STATES  
DESIGNATED/ELECTED OFFICE (DO/EO/US)  
CONCERNING A FILING UNDER 35 U.S.C. 371**

0425-0871P

U.S. APPLICATION NO. (If known, see 37 CFR 1.5)

**10/018956**

INTERNATIONAL APPLICATION NO.

PCT/JP00/04672

INTERNATIONAL FILING DATE

July 12, 2000

PRIORITY DATE CLAIMED

July 14, 1999

**TITLE OF INVENTION**

COOLANT FOR AIR BAG INFLATOR AND PROCESS FOR PROVIDING THE SAME

**APPLICANT(S) FOR DO/EO/US**

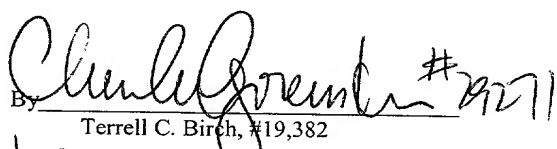
FUKUNAGA, Katsuaki; YAGI, Satoshi; OTA, Mitsunori; CHIBA, Masahiro (now deceased)

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39 (1).
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
  - a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
  - b. ☒ has been transmitted by the International Bureau. WO 01/05632
  - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
  - a. ☒ is transmitted herewith.
  - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4)
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).
  - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
  - b. ☐ have been transmitted by the International Bureau.
  - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
  - d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

**Items 11. to 20. below concern document(s) or information included:**

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98, Form PTO-1449(s), and International Search Report (PCT/ISA/210) with 7 document(s).
12. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
14. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821-1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☒ Other items or information:
  - 1.) Seven (7) Sheets of Formal Drawings
  - 2.) Form PCT/IB/304
  - 3.) Form PCT/IB/308

U.S. APPLICATION NO (if known) <b>10/018956</b>		INTERNATIONAL APPLICATION NO <b>PCT/JP00/04672</b>		ATTORNEY'S DOCKET NUMBER <b>0425-0871P</b>																																																																					
<b>21. <input checked="" type="checkbox"/> The following fees are submitted:</b> <b>BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(5):</b> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO. .... <b>\$1,040.00</b>  International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO ..... <b>\$890.00</b>  International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO. .... <b>\$740.00</b>  International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) ..... <b>\$710.00</b>  International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4). .... <b>\$100.00</b> <b>ENTER APPROPRIATE BASIC FEE AMOUNT =</b>  Surcharge of <b>\$130.00</b> for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)). <table border="1" style="width: 100%; border-collapse: collapse;"><thead><tr><th style="width: 20%;">CLAIMS</th><th style="width: 20%;">NUMBER FILED</th><th style="width: 20%;">NUMBER EXTRA</th><th style="width: 20%;">RATE</th><th style="width: 20%;"></th></tr></thead><tbody><tr><td>Total Claims</td><td>20 - 20 =</td><td>0</td><td>X \$18.00</td><td>\$ 0.00</td></tr><tr><td>Independent Claims</td><td>2 - 3 =</td><td>0</td><td>X \$84.00</td><td>\$ 0.00</td></tr><tr><td colspan="4">MULTIPLE DEPENDENT CLAIM(S) (if applicable) Yes</td><td>+ \$280.00 \$ 280.00</td></tr><tr><td colspan="4"><b>TOTAL OF ABOVE CALCULATIONS =</b></td><td>\$ 1,170.00</td></tr><tr><td colspan="4"><input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.</td><td>\$ 0.00</td></tr><tr><td colspan="4"><b>SUBTOTAL =</b></td><td>\$ 1,170.00</td></tr><tr><td colspan="4">Processing fee of <b>\$130.00</b> for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).</td><td>\$ 0.00</td></tr><tr><td colspan="4"><b>TOTAL NATIONAL FEE =</b></td><td>\$ 1,170.00</td></tr><tr><td colspan="4">Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). <b>\$40.00</b> per property +</td><td>\$ 40.00</td></tr><tr><td colspan="4"><b>TOTAL FEES ENCLOSED =</b></td><td>\$ 1,210.00</td></tr><tr><td colspan="4"></td><td>Amount to be: \$</td></tr><tr><td colspan="4"></td><td>refunded \$</td></tr><tr><td colspan="4"></td><td>charged \$</td></tr></tbody></table>				CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		Total Claims	20 - 20 =	0	X \$18.00	\$ 0.00	Independent Claims	2 - 3 =	0	X \$84.00	\$ 0.00	MULTIPLE DEPENDENT CLAIM(S) (if applicable) Yes				+ \$280.00 \$ 280.00	<b>TOTAL OF ABOVE CALCULATIONS =</b>				\$ 1,170.00	<input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				\$ 0.00	<b>SUBTOTAL =</b>				\$ 1,170.00	Processing fee of <b>\$130.00</b> for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$ 0.00	<b>TOTAL NATIONAL FEE =</b>				\$ 1,170.00	Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). <b>\$40.00</b> per property +				\$ 40.00	<b>TOTAL FEES ENCLOSED =</b>				\$ 1,210.00					Amount to be: \$					refunded \$					charged \$
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c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. <u>02-2448</u> .																																																																									
<b>NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.</b>																																																																									
Send all correspondence to: <b>Birch, Stewart, Kolach &amp; Birch, LLP or Customer No. 2292</b> <b>P.O. Box 747</b> <b>Falls Church, VA 22040-0747</b> <b>(703) 205-8000</b>																																																																									
Date: <u>December 27, 2001</u>																																																																									
 By <u>Terrell C. Birch, #19,382</u>																																																																									

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10/018956  
531 Rec'd PCT/A 27 DEC 2001

PATENT  
0425-0871P

IN THE U.S. PATENT AND TRADEMARK OFFICE

Applicant: FUKUNAGA, Katsuaki et al.  
Int'l. Appl. No.: PCT/JP00/04672  
Appl. No.: New Group:  
Filed: December 27, 2001 Examiner:  
For: COOLANT FOR AIR BAG INFLATOR AND  
PROCESS FOR PROVIDING THE SAME

PRELIMINARY AMENDMENT

**BOX PATENT APPLICATION**

Assistant Commissioner for Patents  
Washington, DC 20231

December 27, 2001

Sir:

The following Preliminary Amendments and Remarks are respectfully submitted in connection with the above-identified application.

AMENDMENTS

IN THE SPECIFICATION:

Please amend the specification as follows:

Before line 1, insert --This application is the national phase under 35 U.S.C. § 371 of PCT International Application No. PCT/JP00/04672 which has an International filing date of July 12, 2000, which designated the United States of America.--

Please replace the paragraph beginning on page 7, line 3, with the following rewritten paragraph:

--When the above-described coolant is produced, a stainless steel is preferably used and especially, SUS304, SUS310S, SUS316 (JIS Standard) can be used. SUS304 (18Cr-8Ni-0.06C) exhibits excellent corrosion resistance as austenitic stainless steel. In addition, an expansion-suppressing means can be formed at the outer peripheral portion of the coolant. The expansion-suppressing means functions as a means to reliably keep a gap between the coolant and the housing (especially at the time of actuation of the inflator) when the coolant is disposed in the inflator. For example, the expansion-suppressing means can be realized by disposing a laminated wire-mesh layer or the like having different wire diameter, pressure loss or the like outside the coolant. In this case, the coolant has a double layer structure, and the outer layer prevents the coolant from expanding, due to a gas pressure at the time of actuation of the inflator, to close the gap between the coolant and the housing.--

Please replace the paragraph beginning on page 19, line 15, with the following rewritten paragraph:

--The coolant 7 is held between the diffuser shell 1 and the closure shell 2 by welding the both shells with each other. In the present embodiment, a short pass preventing means 51 which

covers the inner peripheral surface of the coolant 7 on the diffuser shell 1 side is interposed between a coolant 7 end surface and a ceiling inner surface 29 of the diffuser shell 1 so as to prevent the combustion gas from passing between the coolant 7 end surface and the ceiling inner surface 29 of the diffuser shell 1. The short pass preventing means 51 is integrally formed with a flame-repellent plate 50 for protecting the coolant from a flame of the transfer charge discharged from the flame-transferring hole. This flame-repellent plate 50 may be formed as a separate member from the short pass preventing means 51, or a perforated basket formed at the specified area with a plurality of through holes may be used instead of the flame-repellent plate 50. A gap 9 is secured outside the coolant 7 so that the combustion gas can pass through the entire surface of the coolant 7.--

Please replace the paragraph beginning on page 22, line 18, with the following rewritten paragraph:

--The coolant 107 disposed in the coolant accommodating chamber 130 is for purifying and/or cooling a combustion gas generated in the combustion chamber 122, and a coolant which is formed in the same manner as that of the Embodiment 1, with a small density-difference in the axial direction is used. The coolant 107 is cylindrical in shape, and an end thereof on the combustion chamber 122 side is supported by a coolant supporting

member 132, and the coolant 107 is disposed coaxially with the housing 103 and facing the inner peripheral surface of the housing 103. A gap 109 having a predetermined width and functioning as a gas passage is provided between the outer peripheral surface of the coolant 107 and an inner peripheral surface of the housing 103. In the present embodiment, the coolant supporting member 132 is formed by providing peripheral walls on the inner periphery and the outer periphery of an annular portion 133 having substantially the same shape as an end of the coolant 107. The inner periphery of the coolant 107 is supported by a peripheral wall 134 of the inner peripheral side, and a peripheral wall 135 of the outer peripheral side is held by the inner peripheral surface of the housing 103.--

IN THE CLAIMS:

Please amend the claims as follows:

6. (Amended) A coolant for an air bag inflator according to claim 1, wherein a bulk density of said coolant is 3.0 to 5.0 g cm<sup>-3</sup>, and said coolant has a pressure loss of 10 mmH<sub>2</sub>O to 2000 mmH<sub>2</sub>O with respect to an amount of air of 1000 liters minute<sup>-1</sup> under the atmosphere of 20°C.

7. (Amended) A coolant for an air bag inflator according to claim 1, wherein said coolant is an annular laminated body made of wire mesh formed by plainly knitting stainless-steel wire rods, and said laminated body is compressed.

13. (Amended) A method of producing a coolant according to claim 8, wherein said molded product is compressed also in the radial direction in the compressing process.

14. (Amended) A method of producing a coolant according to claim 8, wherein said molded product is an annular laminated body obtained by forming a plain-knitted wire mesh made of stainless-steel wire rods into a cylindrical body and folding one end of said cylindrical body outwardly and repeatedly.

15. (Amended) A method of producing a coolant according to

claim 8, wherein said molded product is an annular laminated body obtained by forming a plain-knitted wire mesh made of stainless-steel wire rods into a cylindrical body, pressing the cylindrical body in the radial direction to form into a plate body, and then rolling said plate body many times cylindrically.

16. (Amended) A air bag inflator comprising, in a housing thereof with a gas discharge port, an ignition means to be activated upon an impact, gas generating means which is to be ignited and burnt due to activation of the ignition means for generating a combustion gas, and coolant means for purifying and/or cooling said combustion gas, wherein said coolant means is the coolant means according to claim 1.



REMARKS

The specification has been amended to provide a cross-reference to the previously filed International Application.

The specification has also been amended to correct typographical errors.

The claims have been amended to delete improper multiple dependencies.

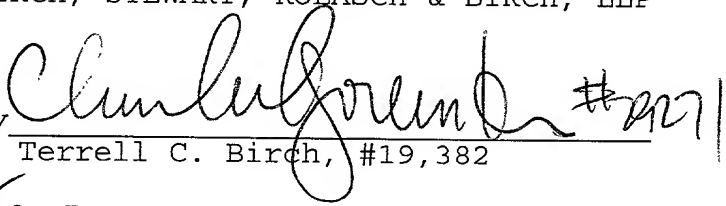
Entry of the above amendments is earnestly solicited. An early and favorable first action on the merits is earnestly solicited.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17; particularly, extension of time fees.

Respectfully submitted,

BIRCH, STEWART, KOLASCH & BIRCH, LLP

By

 #19,382  
Terrell C. Birch, #19,382

✓  
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(703) 205-8000

TCB/rem  
0425-0871P

Attachment:      VERSION WITH MARKINGS TO SHOW CHANGES MADE

VERSION WITH MARKINGS TO SHOW CHANGES MADE

The specification has been amended to provide a cross-reference to the previously filed International Application.

IN THE SPECIFICATION:

The paragraph beginning on page 7, line 3, has been amended as follows:

When the above-described coolant is produced, a stainless steel is preferably used and especially, SUS304, SUS310S, SUS316 (JIS Standard) can be used. SUS304 (18Cr-8Ni-0.06C) exhibits excellent corrosion resistance as austenitic stainless steel. In addition, an expansion-suppressing means can be formed at the outer peripheral portion of the coolant. The expansion-suppressing means functions as a means to reliably keep a gap between the coolant and the housing (especially at the time of actuation of the inflator) when the coolant is disposed in the inflator. For example, the expansion-suppressing means can be realized by disposing a laminated wire-mesh layer or the like having different [linear shape] wire diameter, pressure loss or the like outside the coolant. In this case, the coolant has a double layer structure, and the outer layer prevents the coolant from expanding, due to a gas pressure at the time of actuation of the inflator, to close the gap between the coolant and the housing.

The paragraph beginning on page 19, line 15, has been amended as follows:

The coolant 7 is held between the diffuser shell 1 and the closure shell 2 by welding the both shells with each other. In the present embodiment, a short pass preventing means 51 which covers the inner peripheral surface of the coolant 7 on the diffuser shell 1 side is interposed between a coolant [22] 7 end surface and a ceiling inner surface 29 of the diffuser shell 1 so as to prevent the combustion gas from passing between the coolant [22] 7 end surface and the ceiling inner surface 29 of the diffuser shell 1. The short pass preventing means 51 is integrally formed with a flame-repellent plate 50 for protecting the coolant from a flame of the transfer charge discharged from the flame-transferring hole. This flame-repellent plate 50 may be formed as a separate member from the short pass preventing means 51, or a perforated basket formed at the specified area with a plurality of through holes may be used instead of the flame-repellent plate 50. A gap 9 is secured outside the coolant 7 so that the combustion gas can pass through the entire surface of the housing 103.

The paragraph beginning on page 22, line 18, has been amended as follows:

The coolant 107 disposed in the coolant accommodating

chamber 130 is for purifying and/or cooling a combustion gas generated in the combustion chamber 122, and a coolant which is formed in the same manner as that of the Embodiment 1, with a small density-difference in the axial direction is used. The coolant 107 is cylindrical in shape, and an end thereof on the combustion chamber 122 side is supported by a coolant supporting member 132, and the coolant 107 is disposed coaxially with the housing 103 and [oppositely to] facing the inner peripheral surface of the housing 103. A gap 109 having a predetermined width and functioning as a gas passage is provided between the outer peripheral surface of the coolant 107 and an inner peripheral surface of the housing 103. In the present embodiment, the coolant supporting member 132 is formed by providing peripheral walls on the inner periphery and the outer periphery of an annular portion 133 having substantially the same shape as an end of the coolant 107. The inner periphery of the coolant 107 is supported by a peripheral wall 134 of the inner peripheral side, and a peripheral wall 135 of the outer peripheral side is held by the inner peripheral surface of the housing 103.

IN THE CLAIMS:

The claims have been amended as follows:

6. (Amended) A coolant for an air bag inflator according to [any one of claims 1 to 5] claim 1, wherein a bulk density of said coolant is 3.0 to 5.0 g cm<sup>-3</sup>, and said coolant has a pressure loss of 10 mmH<sub>2</sub>O to 2000 mmH<sub>2</sub>O with respect to an amount of air of 1000 liters minute<sup>-1</sup> under the atmosphere of 20°C.

7. (Amended) A coolant for an air bag inflator according to [any one of claims 1 to 6] claim 1, wherein said coolant is an annular laminated body made of wire mesh formed by plainly knitting stainless-steel wire rods, and said laminated body is compressed.

13. (Amended) A method of producing a coolant according to [any one of claims 8 to 12] claim 8, wherein said molded product is compressed also in the radial direction in the compressing process.

14. (Amended) A method of producing a coolant according to [any one of claims 8 to 13] claim 8, wherein said molded product

is an annular laminated body obtained by forming a plain-knitted wire mesh made of stainless-steel wire rods into a cylindrical body and folding one end of said cylindrical body outwardly and repeatedly.

15. (Amended) A method of producing a coolant according to [any one of claims 8 to 13] claim 8, wherein said molded product is an annular laminated body obtained by forming a plain-knitted wire mesh made of stainless-steel wire rods into a cylindrical body, pressing the cylindrical body in the radial direction to form into a plate body, and then rolling said plate body many times cylindrically.

16. (Amended) A air bag inflator comprising, in a housing thereof with a gas discharge port, an ignition means to be activated upon an impact, gas generating means which is to be ignited and burnt due to activation of the ignition means for generating a combustion gas, and coolant means for purifying and/or cooling said combustion gas, wherein said coolant means is the coolant means according to [any one of claims 1 to 7] claim 1.

## Description

COOLANT FOR AIR BAG INFLATOR AND PROCESS FOR PROVIDING THE SAME

## Technical Field To Which the Present Invention Belongs

The present invention relates to a coolant for an air bag inflator and a process for providing the same.

## Related Art

An air bag apparatus is mounted to a vehicle such as an automobile in order to protect a passenger from the impact of collision. The air bag apparatus actuates an inflator when a sensor detects the impact, and forms a cushion (air bag) between the passenger and the vehicle.

The inflator used for the air bag apparatus is activated by an impact sensor detecting an impact, thereby discharging an operating gas (combustion gas) for inflating the air bag (bag body). The operating gas for inflating the air bag (bag body) is usually cooled and/or purified by coolant means accommodated in a housing of the inflator and then, the gas is discharged from a gas discharge port of the housing and introduced into the air bag.

Conventionally, since the coolant means functionally needs to purify and cool the combustion gas generated due to combustion of the gas generating means, a molded product of wire mesh made of various wire meshes is generally used as the coolant means. In particular, when the molded product of wire mesh is formed to have a desired size, strength and pressure loss, preferably, a

compress-molded product of wire mesh obtained by compressing the molded product of wire mesh in the axial and/or radial direction is used. Such a compress-molded product of wire mesh is generally formed by putting a molded product of metal wire mesh into a mold and compressing with one-shot presswork. And EP00623373 discloses a method of producing the coolant means including a process of compressing with the presswork. According to this method, a wire rods of a cooling material is deformed into a waveform, then put into a mold, and lightly compressed to roughly determine its shape, thereby forming a semi-molded product. Consequently, the semi-molded product is coiled around with wire rods deformed into a waveform and then again placed into the mold and pressed, thereby forming the coolant means.

In the coolant means, the combustion gas generated due to combustion of the gas generating means should pass uniformly through the coolant means, and further, the need to arrange the axis-disposing direction of the coolants in the housing should be eliminated. In a view of the above, it is preferable that inequable density in the axially upper and lower ends of the coolant (inequable in pressure loss in the radial direction) is made as consistent as possible.

However, conventionally, no improvement concerning the unevenness in a radial pressure loss of the coolant has been found. Especially in the case of the compressed molded product of wire mesh obtained by compressing the molded product of wire mesh, mostly, the coolant means is compressed at a stroke(s) only on one axial side. Because of this compression manner, the compressed side



tends to shrink more, and the density of the coolant means in the axial direction becomes uneven. Therefore, the radial pressure losses in the axially upper and lower portion of the coolant cannot be uniformed.

The coolant means produced by such a conventional method has uneven pressure loss due to a difference in the density generated in the axial direction. As a result, in the inflator using such a coolant means, output is varied due to the direction to which density of the coolant means is uneven (i.e., due to the difference of the pressure loss).

#### Disclosure of the Present Invention

Therefore, it is an object of the present invention to provide a coolant to solve the problems of the above conventional coolant means, which is made of wire rods, compressed at least in the axial direction to have a desired size, strength and pressure loss and have a small unevenness in density in the axial direction, and also to provide a method of producing the coolant. It is another object of the invention to provide coolant means which needs no disposing direction in a housing of an inflator.

A coolant means for an air bag inflator of the present invention is obtained by compressing a molded product made of wire rods at least in the axial direction. This coolant means is characterized in that a difference between a radial pressure loss of an axially upper half portion of the coolant and a radial pressure loss of the axially lower half portion of the coolant is made as small as possible. As a result, according to the coolant means of

the present invention, a combustion gas generated due to combustion of the gas generating means can pass uniformly through the coolant means, and it is unnecessary to arrange the disposing direction of the coolant in a housing.

That is, a coolant for an air bag inflator of the present invention is cylindrical in shape, disposed in a housing of the inflator for the air bag in order to cool and/or purify a gas discharged from the inflator, and obtained by compressing axially a molded product made of wire rods on the axially opposite ends. Further, in the coolant obtained by compressing a molded product made of wire rods in the axial direction, an absolute value of a difference between a radial pressure loss of the axially upper half portion of the coolant and a radial pressure loss of the axially lower half portion of the coolant is preferably 10 mmH<sub>2</sub>O or less, and more preferably, 6 mmH<sub>2</sub>O or less at a flow rate of 250 liters/minute under the atmosphere of 20°C.

The radial pressure loss of the axially upper half portion of the coolant is measured in such a manner that an inner surface of the axially lower half of the coolant is covered with a covering member and a gas at a flow rate of 250 liters/minute is introduced into the coolant under the atmosphere of 20°C. And the radial pressure loss of the axially lower half portion of the coolant is measured in such a manner that an inner surface of the axially upper half of the coolant is covered with a covering member and a gas at a flow rate of 250 liters/minute is introduced into the coolant under the atmosphere of 20°C.

In a method of producing a coolant for an air bag inflator

including a compressing process of compressing a cylindrical molded product in the axial direction, by this compressing process, a difference in the pressure losses between the axially opposite ends of the coolant can be 10 mmH<sub>2</sub>O or less when it is measured in accordance with the following method:

<Measuring Method>

1) an inner peripheral surface of a cylindrical coolant is covered from its axial end to its one-half the height with a covering member;

2) one end of the coolant in which the covering member is fitted is closed with a supporting member having a manometer, the other end of the coolant is closed with another supporting member having a gas-inflow pipe and a gas-flow meter, and the coolant is fixed in the axial direction so that air will not leak between the ends of the coolant and the supporting members;

3) the air at 250 liters/minute is introduced from the gas-inflow pipe into an internal space of the covering member under the atmosphere of 20°C and the pressure loss is measured;

4) next, the coolant is turned upside down in the axial direction, the opposite side of 1) (i.e., the side through which the air passed in 3)) is now covered with the covering member, and the pressure loss of the coolant is measured under the same conditions as 2) and 3); and

5) a difference in the pressure loss values obtained in 3) and 4) is obtained, and its absolute value is determined as a difference in the pressure losses in the radial direction in the axial ends of the coolant.

It is preferable that the coolant for an air bag inflator of the present invention is formed by laminating plain-knitted wire mesh having a diameter of 0.3 to 0.6 mm and then, compressing the laminated wire mesh in the radial and axial directions. And it is also preferable that the coolant has a bulk density of 3.0 to 5.0  $\text{g} \cdot \text{cm}^{-3}$ , and more preferably 3.5 to 4.5  $\text{g}/\text{cm}^{-3}$ . And preferably, the coolant has a pressure loss of 10  $\text{mmH}_2\text{O}$  to 2000  $\text{mmH}_2\text{O}$  with respect to an amount of air of 1000  $\text{liters min}^{-1}$  under the atmosphere of  $20^\circ\text{C}$ . Desirably, the coolant is obtained by forming plain-knitted wire mesh made of stainless-steel wire rods into an annular laminated body and compressing the laminated body.

An inflator using the coolant having a small density difference in the axial direction exhibits a stable output performance. That is, in the case of a coolant having a difference in density in the axial direction, when a gas generated from the gas generating means passes through a denser portion in density of the coolant, a residence time of the gas in the coolant becomes longer. Consequently, heat exchange is carried out sufficiently, which lowers a temperature of the generated gas and an output of the inflator in result. On the other hand, when a gas passes through a thinner portion in density of the coolant, a ventilation resistance of that portion is lower than that of the denser portion, the heat exchange is not carried out so effectively, which does not lower a temperature of the generated gas. In the coolant having a density-difference in the axial direction, the output performance varies based on the difference in the temperatures of the generated gases. The coolant of the present invention has a small density

difference in the axial direction and thus, the inflator using this coolant can exhibit the stable output performance.

When the above-described coolant is produced, a stainless steel is preferably used and especially, SUS304, SUS310S, SUS316 (JIS Standard) can be used. SUS304 (18Cr-8Ni-0.06C) exhibits excellent corrosion resistance as austenitic stainless steel. In addition, an expansion-suppressing means can be formed at the outer peripheral portion of the coolant. The expansion-suppressing means functions as a means to reliably keep a gap between the coolant and the housing (especially at the time of actuation of the inflator) when the coolant is disposed in the inflator. For example, the expansion-suppressing means can be realized by disposing a laminated wire-mesh layer or the like having different linear shape, pressure loss or the like outside the coolant. In this case, the coolant has a double layer structure, and the outer layer prevents the coolant from expanding, due to a gas pressure at the time of actuation of the inflator, to close the gap between the coolant and the housing.

The present invention also provides a method of producing a coolant for an air bag inflator including a compressing process of compressing a molded product particularly in the axial direction.

That is, the present invention provides the method of producing a coolant for an air bag inflator including a compressing process of compressing a cylindrical molded product at least in the axial direction, wherein, in the compressing process, axially opposite sides of the molded product are compressed in the axial

direction. Preferably, the compressing process is carried out such that an absolute value of a difference between a radial pressure loss of the axially upper half portion of the coolant and a radial pressure loss of the axially lower half portion of the coolant is adjusted to be 10 mmH<sub>2</sub>O or less at a flow rate of 250 liters/minute under the atmosphere of 20°C. The radial pressure loss of the axially upper half portion can be measured in such a manner that an inner surface of the axially lower half of the coolant produced in the above method is covered with a belt-like member and a gas at a flow rate of 250 liters/minute is introduced into the inside of the coolant under the atmosphere of 20°C. And the radial pressure loss of the axially lower half portion of the coolant can be measured in such a manner that an inner surface of the axially upper half of the coolant is covered with a belt-like member and a gas at a flow of 250 liters/minute is introduced into the inside of the coolant under the atmosphere of 20°C. It is preferable that the compressing process is carried out such that a difference in pressure losses between the axially opposite ends of the coolant is adjusted to be 10 mmH<sub>2</sub>O or less when it is measured in accordance with the above-described measuring method.

Such a compressing process can be carried out, for example, as follows. After the molded product is compressed in the axial direction as the first compression step, the molded product is turned upside down in the axial direction and then, compressed in the axial direction as the second compression step, or alternatively, the molded product is compressed on the axial opposite sides without being turned upside down. In particular,

in the case of compressing the molded product in two steps, it is preferable that compressing distances of the first and second compression steps are substantially equal to each other. In the compressing process, the molded product can be compressed in the radial direction simultaneously or at different timing in addition to being compressed in the axial direction. In this case, a volume of a coolant can be reduced.

The molded product used in the above producing method may be an annular laminated body obtained by forming a plain-knitted wire mesh made of stainless steel wire rods into a cylindrical body, and folding one end of the cylindrical body outwardly and repeatedly. Or the molded product may be an annular laminated body obtained by forming a plain-knitted wire mesh made of stainless steel wire rods into a cylindrical body, pressing the cylindrical body in the radial direction to form a plate body, and rolling the plate body many times cylindrically. In the molded product obtained in this manner, a surface of the cylindrical body comes on the end surface of the coolant, and therefore, the cut portion of the wire mesh is not outcropped on the end face of the material. Therefore, the cut portion does not hurt a hand of a user.

The above coolant or the coolant produced by the above method is used as a coolant means for an air bag inflator comprising, in a housing thereof with a gas discharge port, an ignition means to be activated upon an impact, gas generating means which is to be ignited and burnt by the ignition means for generating a combustion gas, and a coolant means for purifying and/or cooling the combustion gas, thereby realizing an air bag inflator of the present invention.

When the inflator uses the coolant of the present invention, a stable actuating performance can be obtained irrespective of a direction of the coolant. As the members other than the coolant means, such as known gas generating means, ignition means and the like can be used in the inflator.

The air bag inflator is accommodated in a module case together with an air bag (bag body) which introduces therein a gas generated by the inflator to inflate, thereby making an air bag apparatus. In this air bag apparatus, the inflator is actuated on an impact sensor detecting the impact, and a combustion gas is discharged from a gas discharging port of the housing. The combustion gas flows into the air bag to rupture the module cover and expands, thereby forming cushion absorbing the impact between a passenger and a hard structural component in the vehicle.

The coolant of the present invention is made using wire rods and compressed at least in the axial direction to obtain a desired size, strength and pressure loss, and thereby realizing a coolant in which unevenness in the density in the axial direction is reduced and the need of arranging a disposing direction when disposing in the housing is eliminated. And by adopting the above coolant, an air bag inflator with a stable operating output can be realized.

#### Brief Description of the Drawings

Fig. 1 is a perspective view of a cylindrical wire mesh in processing to a coolant of the present invention;

Fig. 2 is a schematic view of an annular molded product formed by folding one end of the cylindrical body outwardly and repeatedly;



Figs.3 are schematic views showing compressing process of the coolant of the invention;

Fig. 4 is a schematic view of a plate body formed by pressing the cylindrical body shown in Fig. 1 in the radial direction;

Fig. 5 is a schematic view of the molded product formed by rolling the plate body into a cylindrical shape many times;

Fig. 6 is a sectional view of an essential portion showing a measuring method of the coolant;

Fig. 7 is a sectional view showing one embodiment of an inflator of the present invention;

Fig. 8 is a sectional view showing another embodiment of the inflator of the invention; and

Fig. 9 is a view showing a structure of an air bag apparatus of the present invention.

#### Description of reference Numerals

3	housing
4	ignition means
5	transfer charge
6	gas generating agent
7	coolant
14	initiator collar
22	combustion chamber
23	ignition means accommodating chamber
31	cylindrical body
33, 35	molded product
34	plate body

40                    covering member  
42, 45               supporting member  
43                    gas-inflow pipe

#### Embodiments of the Present Invention

Hereinafter, embodiments of the present invention will be explained based on the drawings.

##### "Embodiment of Coolant"

A coolant for an air bag of the present invention can be produced in the following manner. First, stainless steel wires having a wire diameter of 0.3 to 0.6 mm are plain-knitted to form a cylindrical body 31 as shown in Fig. 1. Then, as shown in Fig. 2, one end 32 of this cylindrical body 31 is folded outwardly and repeatedly to form an annular laminated body as a molded product 33. The number of folding operations is appropriately determined in view of a diameter of the wire, a thickness of the coolant and the like. Next, a following compressing process is performed. As shown in Fig. 3, the molded product 33 is put into a mold (not shown), and is compressed on one side in the axial direction as the first compression step (Fig. 3a). Then, the molded product 33 is turned upside down in the axial direction (Fig. 3b) and is again compressed in the axial direction as the second compression step (Fig. 3c). In the first and second compression steps, the compression distances is adjusted to be substantially equal to each other. Further, such a compressing process is performed so that an absolute value of a difference between the respective radial pressure losses of the axially upper half and the axially lower half of the molded

product 33 is adjusted to be 10 mmH<sub>2</sub>O or less, more preferably 6 mmH<sub>2</sub>O or less at a flow rate of 250 liters/minute under the atmosphere of 20°C. The molded product 33 explained based on Fig. 2 can also be formed by other method shown in Figs.4 and 5. In this method, after forming the cylindrical body 31 shown in Fig. 1, the cylindrical body 31 is pressed in the radial direction to form a plate body 34 as shown in Fig. 4. Then, as shown in Fig. 5, the plate body 34 is cylindrically rolled over and over to be an annular laminated body as a molded product 35. This molded product 35 can be compressed in the same manner as that shown in Fig. 3 to form a coolant 7. A compressing process of the molded product 35 can be performed in the same manner as shown in Fig.3 such that, after the first compression step, the molded product 35 is turned upside down and then the second compression step is performed. Alternatively, the molded product 35 can be put in the mold and compressed on the axially opposite sides without turning the product upside down.

With the above-described manufacturing method, a coolant made of compressed wire rods with a uniform pressure loss can be obtained. Concretely, by controlling the compressing process in the above manner, can be obtained the coolant for an air bag inflator, which is made of wire rods, formed by being compressed in the axial direction, and in which an absolute value of the difference between the respective radial pressure losses of the axially upper half and the axially lower half is 10 mmH<sub>2</sub>O or less at a flow rate of 250 liters/minute under the atmosphere of 20°C.

The coolant 7 formed in the above-described manner has such

a shape 36 that loop-like meshes in each layer are crushed, and the crushed meshes are laminated in the radial direction.

Therefore, a gap structure of the coolant becomes complicated, and the coolant exhibits an excellent scavenging function. From this point of view, it is preferable that the coolant is adjusted so that a bulk density of the coolant becomes  $3.0$  to  $5.0 \text{ g} \cdot \text{cm}^{-3}$  in the above compressing process, and that the pressure loss in general becomes  $10 \text{ mmH}_2\text{O}$  to  $2000 \text{ mmH}_2\text{O}$  with respect to an amount of air of  $1000 \text{ liters/minute}$  under the atmosphere of  $20^\circ\text{C}$ .

It is possible to form a coolant having a double layer structure by inserting another laminated body into the inside of the molded product 33 or 35 and compressing these. The other laminated body can be formed, for example, by winding about twice the plate body 34 shown in Fig. 4 made of wire mesh having a diameter of  $0.5 \text{ mm}$  as shown in Fig. 5.

"Example"

Table 1 shows a result of a test of measuring a pressure loss carried out with the above-described coolant at the flow rate of  $250 \text{ liters/minute}$ . In this test, the apparatus shown in Fig. 6 is used and the following method is adopted.

Table 1

Data of Pressure Loss of Coolant1  $\phi 60 \times \phi 47 \times h29.5$  (250L/min)

(mmaq)

No.	Product manufactured under the current mass-production			
	All	Upper portion	Lower portion	Difference between upper and lower portions
1	7	46	23	23
2	13	38	27	11
3	16	41	31	10
4	11	38	26	12
5	13	40	27	13
6	13	46	24	22
Ave.	12.2	41.5	26.3	

(mmaq)

No.	Product manufactured by the new production (two times compressing processes)			
	All	Upper portion	Lower portion	Difference between upper and lower portions
1	12	40	31	9
2	16	42	32	10
3	17	45	35	10
4	19	39	38	1
5	17	38	40	2
6	14	42	32	10
Ave.	15.8	41.0	34.7	

2  $\phi 58 \times \phi 47 \times h26$  (250L/min)

(mmaq)

No.	Product manufactured under the current mass-production			
	All	Upper portion	Lower portion	Difference between upper and lower portions
1	8	28	18	10
2	10	31	17	14
3	8	33	21	12
4	8	35	23	12
5	9	28	23	6
6	9	35	24	11
Ave.	8.7	31.7	21.0	

(mmaq)

No.	Product manufactured by the new production (two times compressing processes)			
	All	Upper portion	Lower portion	Difference between upper and lower portions
1	10	28	28	0
2	6	28	27	1
3	10	32	28	4
4	9	29	29	0
5	10	27	23	4
6	11	28	30	2
Ave.	9.3	28.7	27.5	

the Upper portion: the upper side is pressed in the second compression step

the Lower portion: the lower side is pressed in the second compression step

#### <Method of the Test>

1) An inner peripheral surface of the cylindrically formed coolant 7 is covered from its axial end to one half of the height with an annular covering member 40.

2) With the covering member 40 inserted inside, one end of the coolant 7 is closed with a supporting member 42 having a manometer 41 and the other end of the coolant 7 is closed with a supporting member 45 having a gas-inflow pipe 43 and a gas-flow meter 44. The coolant 7 is fixed in the axial direction so that air will not leak between the ends of the coolant 7 and the supporting members 42 and 45.

3) The air at 250 liters/minute is introduced from the gas-inflow pipe 43 into the internal space of the covering member 40, and the pressure loss is measured.

4) Next, the coolant 7 is turned upside down in the axial direction, the remained portion of the coolant which has not been covered in 1) (i.e., the portion through which the air passed in 3)) is now covered with the covering member 40, and the pressure loss of the coolant 7 is measured under the same conditions as 2) and 3).

5) A difference in the pressure loss values obtained in 3) and 4) is obtained, and its absolute value is determined as a difference in pressure losses in the radial direction of the axial ends of the coolant 7.

#### "Embodiment of Inflator"

Fig. 7 is a longitudinal sectional view of one embodiment of an inflator for an air bag of the present invention.

This inflator comprises a housing 3 formed by joining a diffuser shell 1 having a gas discharge port and a closure shell 2 forming an inner accommodating space together with the diffuser, and a inner cylindrical member 13 in a substantially cylindrical

shape disposed in the housing concentrically, an ignition means accommodating chamber 23 defined inside the inner cylinder member 13, and a combustion chamber 22 defined outside the inner cylinder member 13. In the ignition means accommodating chamber 23, a ignition means comprising an electric ignition type ignition means 4 to be activated upon the impact and a transfer charge 5 to be ignited upon the activation of the ignition means for generating a flame is accommodated. And in the combustion chamber 22, a gas generating agent 6 to be ignited and burnt by the flame of the transfer charge 5 for generating a combustion gas is accommodated, being supported by an under plate 18. The ignition means 4 is fixed in an initiator collar 14 made of iron, and a skirt of the initiator collar 14 is fixed by crimping a lower end 21 of the inner cylindrical member 13. By making the initiator collar 14 of iron, the ignition means can be reliably fixed in the inflator even due to a high temperature. With this feature, even when the inflator is ignited under a high temperature, the initiator collar can sufficiently resist a combustion internal pressure without lowering its strength and can maintain its ability and function.

The inner cylinder member 13 defining the combustion chamber 22 and the ignition means accommodating chamber 23 is provided with a flame-transferring hole 26 closed by a seal tape 27. Since the seal tape 27 is ruptured by a flame of the transfer charge 5, the ignition means accommodating chamber 23 and the combustion chamber 22 can be in communication with each other through the flame-transferring hole 26.

A substantially cylindrical coolant 7 having a small



difference of density in the axial direction is disposed so as to surround the outer periphery of the combustion chamber 22 storing the gas generating agent 6. The coolant 7 is for purifying and/or cooling a combustion gas generated due to combustion of the gas generating agent 6. The coolant 7 is formed by compressing, at least in the axial direction, the upper and lower opposite ends of the molded product made of wire rods.

Particularly, in the inflator shown in the present embodiment, the internal pressure at the time of combustion of the gas generating agent 6 in the housing 3 is adjusted by the total sum of the opening areas ("the total opening area" hereinafter) of all the gas discharge ports 11 formed in the diffuser shell 1. Accordingly, a pressure loss of the coolant 7 in the radial direction is set smaller than a pressure loss of all gas discharge ports 11.

The coolant 7 is held between the diffuser shell 1 and the closure shell 2 by welding the both shells with each other. In the present embodiment, a short pass preventing means 51 which covers the inner peripheral surface of the coolant 7 on the diffuser shell 1 side is interposed between a coolant 22 end surface and a ceiling inner surface 29 of the diffuser shell 1 so as to prevent the combustion gas from passing between the coolant 22 end surface and the ceiling inner surface 29 of the diffuser shell 1. The short pass preventing means 51 is integrally formed with a flame-repellent plate 50 for protecting the coolant from a flame of the transfer charge discharged from the flame-transferring hole. This flame-repellent plate 50 may be formed as a separate member from the short pass preventing means 51, or a perforated basket formed

at the specified area with a plurality of through holes may be used instead of the flame-repellent plate 50. A gap 9 is secured outside the coolant 7 so that the combustion gas can pass through the entire surface of the coolant 7.

The gas discharge ports 11 formed in the diffuser shell 1 are closed by a seal tape 25 to block entering of the air. The seal tape 25 is ruptured when the gas is discharged. This seal tape 25 is for protecting the gas generating agent from the outside moisture, and has no effect on adjusting of performance such as combustion internal pressure.

In the inflator constructed in the above-described manner, the electric ignition type ignition means 4 is activated by an activation signal outputted from the sensor detecting an impact to ignite and burn the transfer charge 5. A flame of the burnt transfer charge 5 is discharged from the flame-transferring hole 26 of the inner cylinder member 13 into the combustion chamber 22, and then ignites and burns the gas generating agent 6 in the combustion chamber 22. By the combustion of the gas generating agent 6, a large amount of combustion gas is generated. The combustion gas is cooled while the gas passes through the coolant 7, the combustion residues in the gas are collected, and then, the gas ruptures the seal tape 25 and is discharged from the gas discharge ports 11. When the combustion gas passes through the coolant 7, the combustion gas can be purified and cooled, using the entire surface of the coolant 7 because of the gap 9 secured on the outer periphery of the coolant 7. However, if a portion (the upper portion) of the inner peripheral surface of the coolant 7

is covered with the flame-repellent plate as shown in this embodiment, or is covered with the upper portion of the perforated basket, the combustion gas generated due to combustion of the gas generating agent 6 cannot pass through the covered portion, nor the gas cannot be cooled or purified properly. Therefore, if a coolant, which has an uneven density with a higher density portion and a lower density portion in the axial direction because of the compression manner such as the conventional coolant, is used, the output performance of the inflator is varied depending upon which portion between a higher density portion and a lower density portion is covered. However, if the uneven density in the axial direction is small such as the coolant 7 of the present invention, a stable operational output can be obtained even if which one of the ends comes closer to the housing. Further, the coolant does not need a disposing direction, and there is no effect on the operational performance even if which one of the ends comes closer to the housing. Thus, it is unnecessary to arrange the disposing direction when the coolant is assembled into the inflator, and productivity can be improved.

Fig. 8 is a longitudinal sectional view showing another embodiment of the inflator for air bag according to the present invention. This inflator has a structure particularly suitable for disposing on an passenger side.

The inflator shown in this drawing uses a cylindrical housing 103 having an axial length longer than outermost diameter. An inner space of the housing 103 is divided into a combustion chamber 122 storing a gas generating agent 106 and a coolant accommodating

chamber 130 accommodating a coolant 107. Both the chambers are conjoined with each other in the axial direction. In the portion of a peripheral wall of the housing 103 where the coolant accommodating chamber 130 is provided, a plurality of gas discharge ports 111 are formed. The gas discharge ports 111 are closed by seal tapes 125 for moisture-proof inside the housing 103.

In addition to the gas generating agent 106, ignition means, which includes an electric ignition type ignition means 104 to be activated upon an impact and an transfer charge 105 which is to be ignited and burnt upon activation of the ignition means 104 for generating a flame, is disposed in the combustion chamber 122. In Fig. 4, the ignition means is formed as a structure comprising an initiator collar 114 fixed on the end surface of the housing, an ignition means 104 secured to the initiator collar 114, an transfer charge 105 disposed adjacent to the ignition means 104, and a cylindrical container 131 surrounding the transfer charge 105 and being fixed to the initiator collar 114.

The coolant 107 disposed in the coolant accommodating chamber 130 is for purifying and/or cooling a combustion gas generated in the combustion chamber 122, and a coolant which is formed in the same manner as that of the Embodiment 1, with a small density-difference in the axial direction is used. The coolant 107 is cylindrical in shape, and an end thereof on the combustion chamber 122 side is supported by a coolant supporting member 132, and the coolant 107 is disposed coaxially and oppositely to the inner peripheral surface of the housing 103. A gap 109 having a predetermined width and functioning as a gas passage is provided

between the outer peripheral surface of the coolant 107 and an inner peripheral surface of the housing 103. In the present embodiment, the coolant supporting member 132 is formed by providing peripheral walls on the inner periphery and the outer periphery of an annular portion 133 having substantially the same shape as an end of the coolant 107. The inner periphery of the coolant 107 is supported by a peripheral wall 134 of the inner peripheral side, and a peripheral wall 135 of the outer peripheral side is held by the inner peripheral surface of the housing 103.

A sectioning member 136, which divides the combustion chamber 122 and the coolant accommodating chamber 130, comprises a circular portion 137 closing the housing in the radial direction, and a peripheral wall 138 integrally formed with a peripheral edge of the circular portion 137. The circular portion 137 is provided with a communication hole 145 for communicating both chambers. A combustion gas generated in the combustion chamber 122 reaches the coolant accommodating chamber 130 through the communication hole 145. In the present embodiment, the sectioning member 136 is provided with a communication hole 145 having substantially the same size as an inner diameter of the coolant 107. A wire mesh 139 is disposed on the communication hole 145 so that the gas generating agent 106 in the combustion chamber 122 should not move into the coolant accommodating chamber 130 at the time of combustion. Any kind of wire mesh may be used as the wire mesh 139 as long as a size of mesh is good enough to block movement of the gas generating agent 106 during combustion, not having a ventilation resistance such as to control the combustion performance. Of course, an

expanded metal can be used instead of the wire mesh.

In the inflator in the present embodiment, the transfer charge 105 is burnt by activation of the ignitor 104 due to an activation signal transmitted from an impact sensor or the like which detects an impact, and the flame thereof ejects from the flame-transferring hole 126 formed in the cylindrical container 131 to ignite and burn the gas generating agent 106. A combustion gas generated by the combustion of the gas generating agent 106 flows into the coolant accommodating chamber 130 through the communication hole 145 of a partition wall 136. The combustion gas passes through the entire surface of the coolant 107 and is purified and cooled, and then ruptures the seal tapes 125 and is discharged from the gas discharge ports 111.

In Fig. 8, the numeral 140 designates a stud bolt for mounting the inflator to a module case.

#### "Embodiment of Air Bag Apparatus"

Fig. 9 shows an embodiment of an air bag apparatus of the present invention provided with an inflator using an electric ignition type ignition means.

This air bag apparatus comprises an inflator 200, an impact sensor 201, a control unit 202, a module case 203 and an air bag 204.

As the inflator 200, the inflator explained based on Fig. 1 is used, and its activation performance is adjusted to give an occupant as a small impact as possible at the initial activation process of the inflator.

The impact sensor 201 can comprise a semiconductor type

acceleration sensor for example. In the semiconductor type acceleration sensor, four semiconductor strain gauges are formed on a beam of a silicon substrate designed to bend when acceleration is applied, and these semiconductor strain gauges are bridge-connected. When the acceleration is applied, the beam is bent, and strain is generated on its surface. The resistance of the semiconductor strain gauge is changed due to this strain, and the change in resistance is detected as a voltage signal in proportion to the acceleration.

The control unit 202 includes an ignition judging circuit to which a signal from the semiconductor type acceleration sensor is inputted. The control unit 202 starts calculation when the impact signal from the sensor 201 exceeds a certain value, and when the calculated result exceeds a certain value, the control unit outputs an activation signal to the ignition means 4 of the inflator 200.

The module case 203 is formed of polyurethane for example, and includes a module cover 205. The air bag 204 and the inflator 200 are accommodated in the module case 203, thereby forming a pad module. When the pad module is mounted on the driver side of an automobile, the pad module is usually mounted to a steering wheel 207.

The air bag 204 is formed of nylon (e.g., nylon 66) or polyester, its bag opening 206 surrounds the gas discharge port of the inflator, and the air bag 204 is fixed to a flange of the inflator in a folded state.

When the semiconductor type acceleration sensor 201 senses

an impact at the time of collision of an automobile, its signal is sent to the control unit 202, and when the impact signal from the sensor exceeds the certain value, the control unit 202 starts calculation. When the calculated result exceeds the certain value, the control unit outputs an activation signal to the ignition means 4 of the inflator 200. With this activation, ignition means (12a, 12b) are activated to ignite the gas generating agent, and the gas generating agent is burnt to generate a gas. This gas is ejected into the air bag 204, thereby allowing the air bag to break the module cover 205 and inflating to form a cushion for absorbing an impact between the steering wheel 207 and the occupant.



## Claims

1. A coolant for an air bag inflator which is cylindrical in shape, disposed in a housing of said inflator in order to cool and/or purify a gas discharged from said inflator, wherein said coolant is obtained by compressing a molded product made of wire rods on the axially opposite ends thereof.

2. A coolant for an air bag inflator according to claim 1, which is cylindrical in shape, disposed in a housing of said inflator in order to cool and/or purify a gas discharged from said inflator, wherein said coolant is obtained by compressing a molded product made of wire rods at least in the axial direction, and an absolute value of a difference between a radial pressure loss of the axially upper half portion of said coolant and a radial pressure loss of the axially lower half portion of said coolant is 10 mmH<sub>2</sub>O or less at a flow rate of 250 liters/minute under the atmosphere of 20°C.

3. A coolant for an air bag inflator according to claim 2, wherein an absolute value of the difference between the radial pressure losses of the axially upper half portion of said coolant and the radial pressure loss of the axially lower half portion of said coolant is 6 mmH<sub>2</sub>O or less at a flow rate of 250 liters/minute under the atmosphere of 20°C.

4. A coolant for an air bag inflator according to claim 2 or 3, wherein the radial pressure loss of the axially upper half portion

of said coolant is measured in such a manner that an inner surface of the axially lower half of said coolant is covered with a covering member and a gas at a flow rate of 250 liters/minute is introduced into the inside of said coolant under the atmosphere of 20°C, and the radial pressure loss of the axially lower half portion of said coolant is measured in such a manner that an inner surface of the axially upper half of said coolant is covered with a covering member and a gas at a flow rate of 250 liters/minute is introduced into the inside of said coolant under the atmosphere of 20°C.

5. A coolant for an air bag inflator according to claim 1, which is cylindrical in shape, disposed in a housing of said inflator for the air bag in order to cool and/or purify a gas discharged from said inflator, wherein said coolant is obtained by compressing a molded product made of wire rods at least in the axial direction, and a difference in pressure losses between axially opposite ends of said coolant is 10 mmH<sub>2</sub>O or less, when it is measured in accordance with the following method:

- 1) an inner peripheral surface of a cylindrically formed coolant is covered from its axial end to its one-half the height with an annular covering member;

- 2) one end of said coolant in which the covering member is fitted is closed with a supporting member having a manometer, the other end of said coolant is closed with another supporting member having a gas-inflow pipe and a gas-flow meter, and said coolant is fixed axially so that air will not leak between the ends of said coolant and the supporting members;

3) the air at a flow rate of 250 liters/minute is introduced from the gas-inflow pipe into an inner space of the covering member under the atmosphere of 20°C, and the pressure loss is measured;

4) next, said coolant is turned upside down in the axial direction, the opposite side of 1) (i.e., the side through which the air passed in 3)) is now covered with the covering member, and the pressure loss of said coolant is measured under the same conditions as 2) and 3); and

5) a difference in the pressure loss values obtained in 3) and 4) is obtained, and its absolute value is determined as a difference in radial pressure losses in the axial ends of said coolant.

6. A coolant for an air bag inflator according to any one of claims 1 to 5, wherein a bulk density of said coolant is 3.0 to 5.0 g · cm<sup>-3</sup>, and said coolant has a pressure loss of 10 mmH<sub>2</sub>O to 2000 mmH<sub>2</sub>O with respect to an amount of air of 1000 liters minute<sup>-1</sup> under the atmosphere of 20°C.

7. A coolant for an air bag inflator according to any one of claims 1 to 6, wherein said coolant is an annular laminated body made of wire mesh formed by plainly knitting stainless-steel wire rods, and said laminated body is compressed.

8. A method of producing a coolant for an air bag inflator comprising the steps of compressing a cylindrical molded product at least axially, wherein, in said compressing process, said molded

product is compressed in the axial direction on the axially opposite ends thereof.

9. A method of producing a coolant according to claim 8, wherein said compressing process is carried out such that an absolute value of a difference between a radial pressure loss of the axially upper half portion of the molded product and a radial pressure loss of the axially lower half portion of the molded product becomes 10 mmH<sub>2</sub>O or less at a flow rate of 250 liters/minute under the atmosphere of 20°C.

10. A method of producing a coolant according to claim 8, wherein said compressing process is carried out such that a difference in pressure losses between axially opposite ends of the molded product is adjusted to be 10 mmH<sub>2</sub>O or less when it is measured in accordance with the following method:

1) an inner peripheral surface of a cylindrical coolant is covered from its axial end to its one-half the height with a covering member;

2) one end of said coolant in which the covering member is fitted is closed with a supporting member having a manometer, the other end of said coolant is closed with another supporting member having a gas-inflow pipe and a gas-flow meter, and said coolant is fixed axially so that air will not leak between the ends of said coolant and the supporting members;

3) the air at a flow rate of 250 liters/minute is introduced from the gas-inflow pipe into an inner space of the covering member

under the atmosphere of 20°C, and the pressure loss is measured;

4) next, said coolant is turned upside down in the axial direction, the opposite side of 1) (i.e., the side through which air passed in 3)) is now covered with the covering member, and the pressure loss of said coolant is measured under the same conditions as 2) and 3); and

5) a difference in the pressure-loss values obtained in 3) and 4) is obtained, and its absolute value is determined as a difference in radial pressure losses in the axial ends of said coolant.

11. A method of producing a coolant according to any one of claims 8 to 10, wherein said compressing process includes the first compression step of compressing the molded product in its axial direction, and the first process is followed by the second compression step of turning the molded product axially upside down and further compressing the molded product in the axial direction.

12. A method of producing a coolant according to 10, wherein compressing distances in the first and second compression steps are substantially equal.

13. A method of producing a coolant according to any one of claims 8 to 12, wherein said molded product is compressed also in the radial direction in the compressing process.

14. A method of producing a coolant according to any one of claims

8 to 13, wherein said molded product is an annular laminated body obtained by forming a plain-knitted wire mesh made of stainless-steel wire rods into a cylindrical body and folding one end of said cylindrical body outwardly and repeatedly.

15. A method of producing a coolant according to any one of claims 8 to 13, wherein said molded product is an annular laminated body obtained by forming a plain-knitted wire mesh made of stainless-steel wire rods into a cylindrical body, pressing the cylindrical body in the radial direction to form into a plate body, and then rolling said plate body many times cylindrically.

16. A air bag inflator comprising, in a housing thereof with a gas discharge port, an ignition means to be activated upon an impact, gas generating means which is to be ignited and burnt due to activation of the ignition means for generating a combustion gas, and coolant means for purifying and/or cooling said combustion gas, wherein said coolant means is the coolant means according to any one of claims 1 to 7.

17. An air bag apparatus comprising:

an air bag inflator;

an impact sensor for detecting an impact to activate said inflator;

an air bag introducing therein a gas generated by said inflator to inflate; and

a module case for accommodating said air bag, wherein

said air bag inflator is the inflator according to claim 16.

## DRAWINGS

Fig. 1

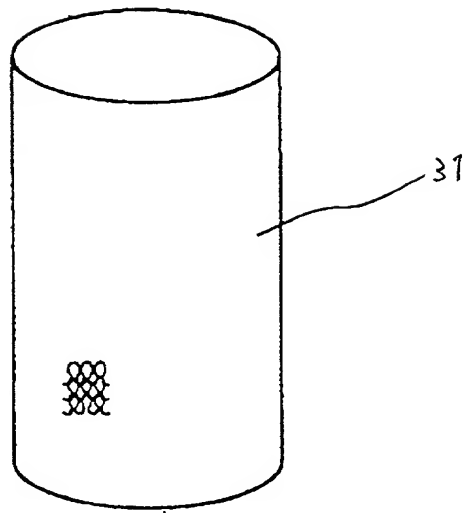


Fig. 2

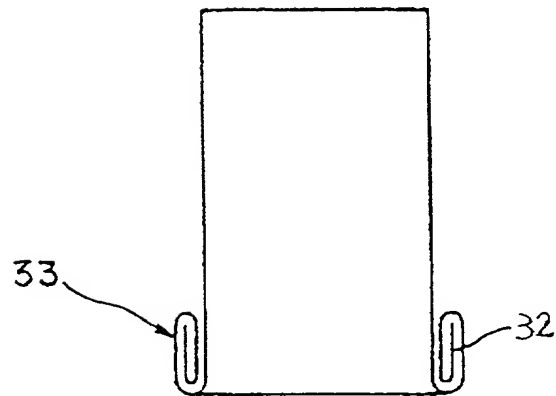




Fig. 3

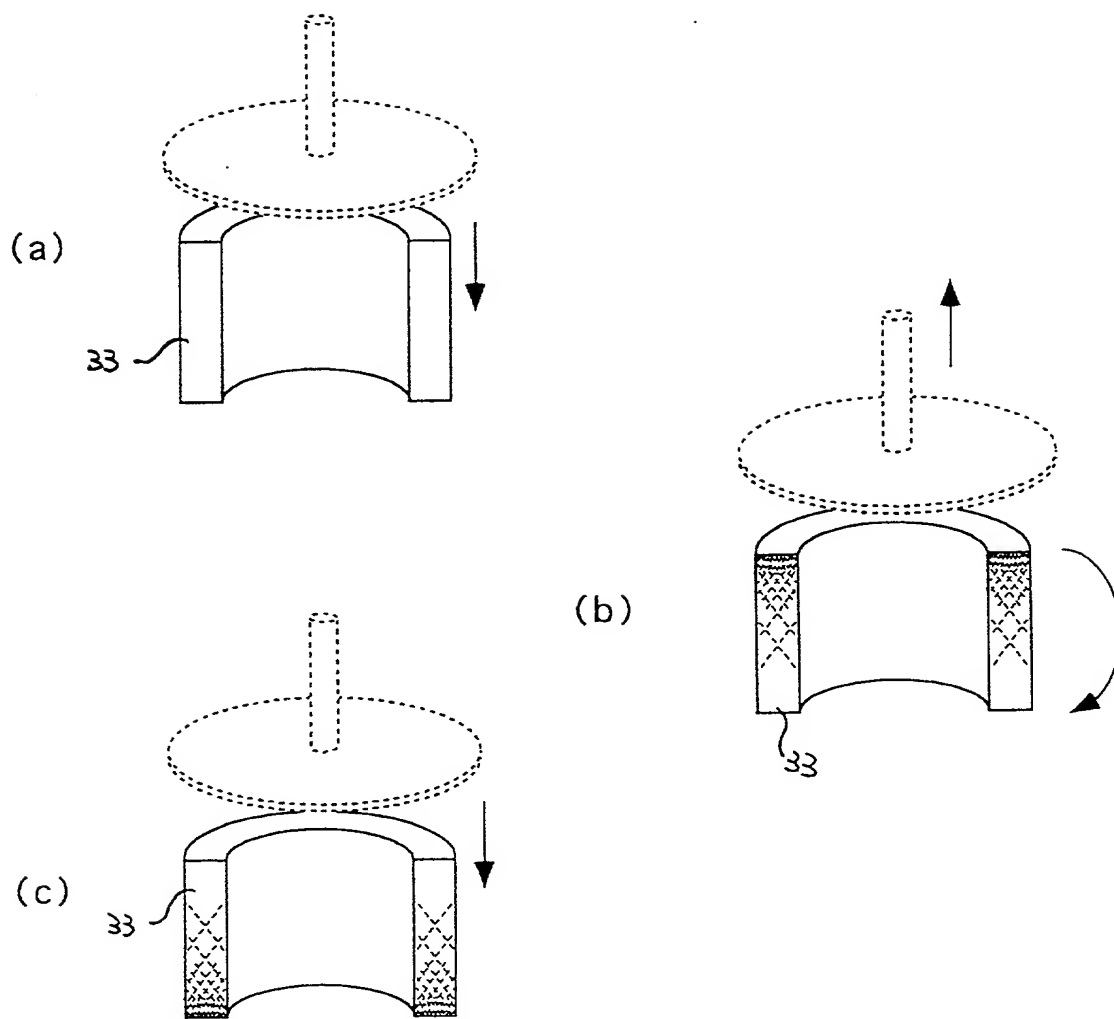


Fig. 4

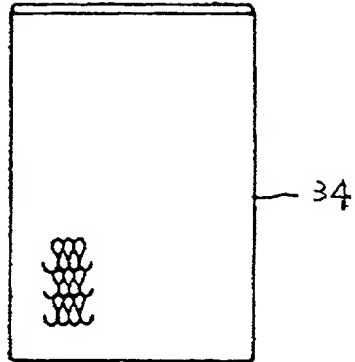


Fig. 5

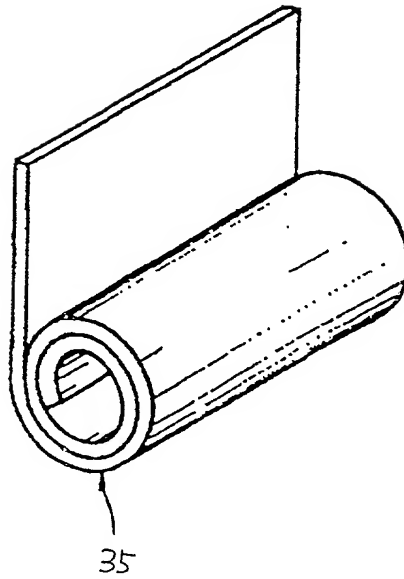


Fig. 6

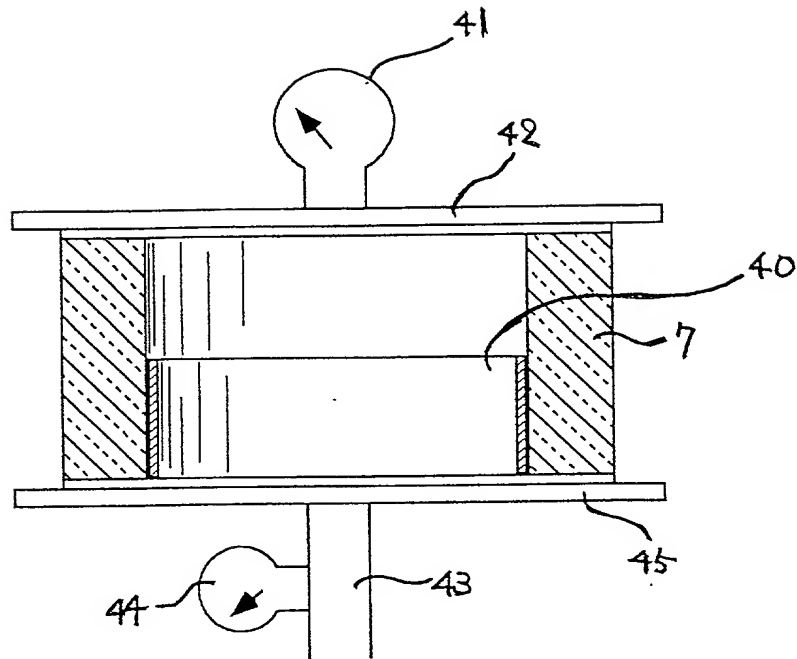


Fig. 7

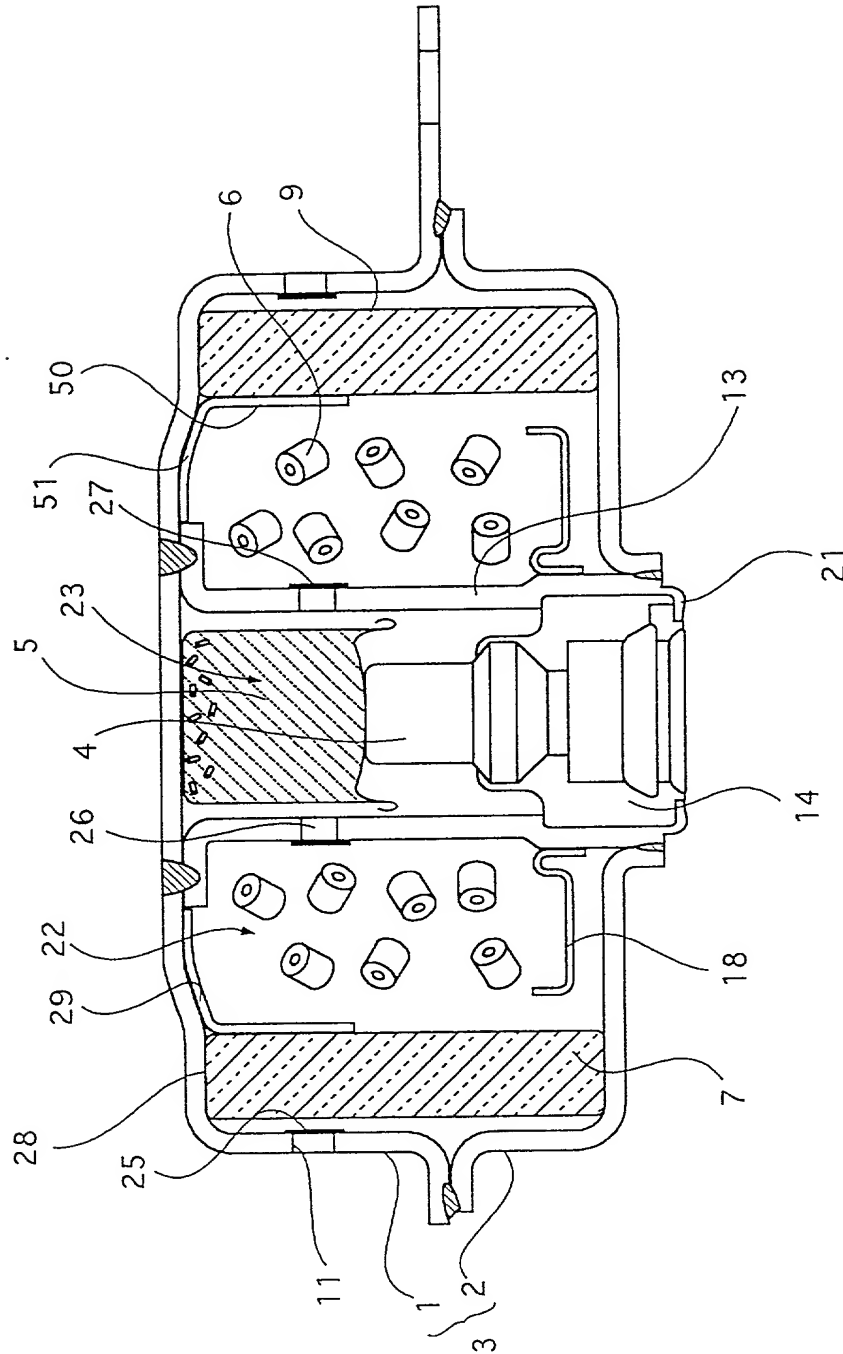


Fig. 8

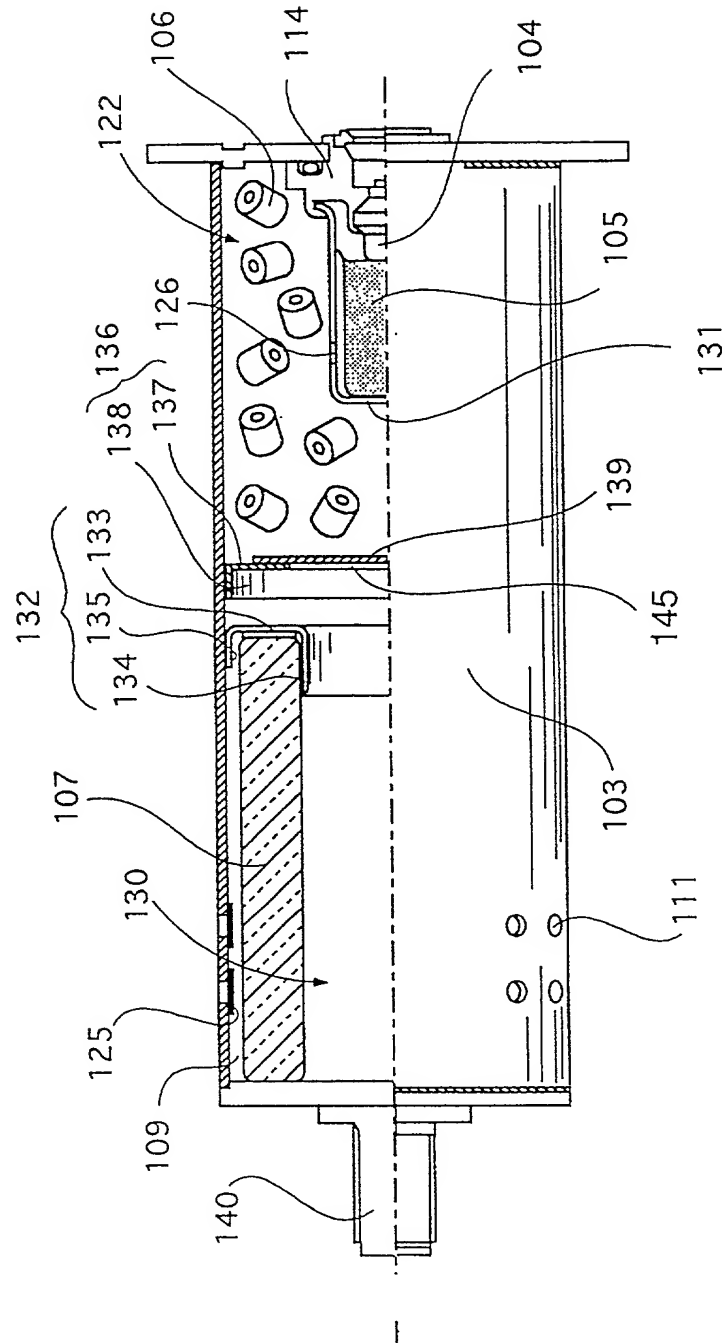
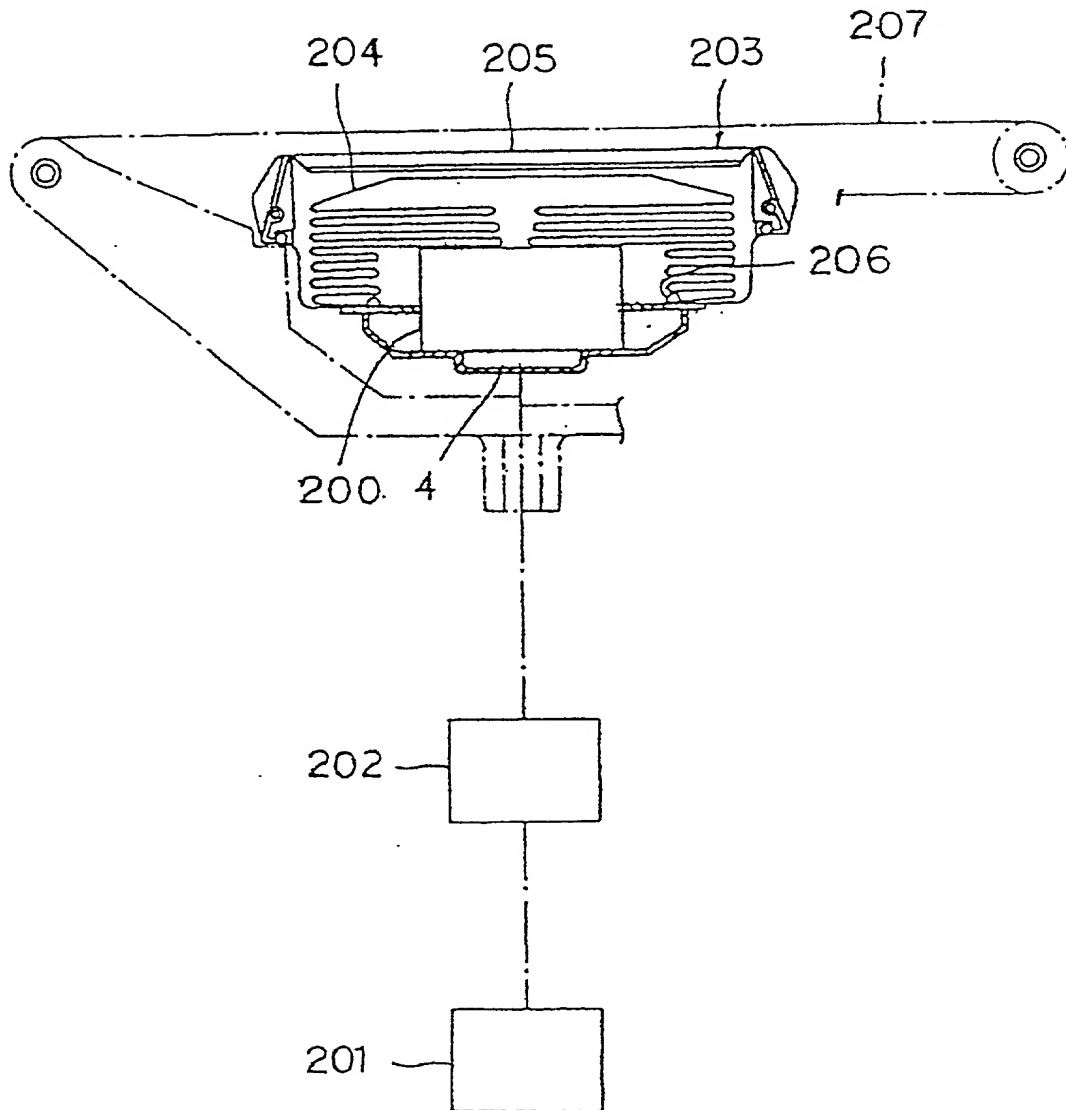


Fig. 9



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## COMBINED DECLARATION AND POWER OF ATTORNEY FOR PATENT AND DESIGN APPLICATIONS

As a below named inventor, I hereby declare that: my residence, post office address and citizenship are as stated next to my name; that I verily believe that I am the original, first and sole inventor (if only one inventor is named below) or an original, first and joint inventor (if plural inventors are named below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Insert Title:

COOLANT FOR AIR BAG INFLATOR AND PROCESS FOR PROVIDING THE SAME

Fill in Appropriate  
 Information -  
 For Use Without  
 Specification  
 Attached:

the specification of which is attached hereto. If not attached hereto,

the specification was filed on \_\_\_\_\_ as  
 United States Application Number \_\_\_\_\_;  
 and amended on \_\_\_\_\_ (if applicable) and/or  
 the specification was filed on July 12, 2000 as PCT  
 International Application Number PCT/JP00/04672; and was  
 amended under PCT Article 19 on \_\_\_\_\_ (if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I do not know and do not believe the same was ever known or used in the United States of America before my or our invention thereof, or patented or described in any printed publication in any country before my or our invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representative or assigns more than twelve months (six months for designs) prior to this application, and that no application for patent or inventor's certificate on this invention has been filed in any country foreign to the United States of America prior to this application by me or my legal representatives or assigns, except as follows.

I hereby claim foreign priority benefits under Title 35, United States Code, §119(a)-(d) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Insert Priority  
 Information:  
 (if appropriate)

### Prior Foreign Application(s)

### Priority Claimed

<u>11-200179</u> (Number)	<u>Japan</u> (Country)	<u>July 14, 1999</u> (Month/Day/Year Filed)	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No
_____ (Number)	_____ (Country)	_____ (Month/Day/Year Filed)	<input type="checkbox"/> Yes	<input type="checkbox"/> No
_____ (Number)	_____ (Country)	_____ (Month/Day/Year Filed)	<input type="checkbox"/> Yes	<input type="checkbox"/> No
_____ (Number)	_____ (Country)	_____ (Month/Day/Year Filed)	<input type="checkbox"/> Yes	<input type="checkbox"/> No

I hereby claim the benefit under Title 35, United States Code, §119(e) of any United States provisional applications(s) listed below.

Insert Provisional  
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_____ (Application Number)	_____ (Filing Date)

All Foreign Applications, if any, for any Patent or Inventor's Certificate Filed More than 12 Months (6 Months for Designs) Prior to the Filing Date of This Application:

Country	Application Number	Date of Filing (Month/Day/Year)
_____	_____	_____
_____	_____	_____

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I hereby claim the benefit under Title 35, United States Code, §120 of any United States and/or PCT application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States and/or PCT application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to the patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

Insert Prior U.S.  
 Application(s):  
 (if any)

_____ (Application Number)	_____ (Filing Date)	_____ (Status - patented, pending, abandoned)
_____ (Application Number)	_____ (Filing Date)	_____ (Status - patented, pending, abandoned)

I hereby appoint the practitioners at CUSTOMER NO. 2292 as my attorneys or agents to prosecute this application and/or an international application based on this application and to transact all business in the United States Patent and Trademark Office connected therewith and in connection with the resulting patent based on instructions received from the entity who first sent the application papers to the practitioners, unless the inventor(s) or assignee provides said practitioners with a written notice to the contrary:

Send Correspondence to:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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1-00  
Full Name of First  
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Full Name of Fourth  
Inventor, if any:  
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4-11  
Full Name of Fifth  
Inventor, if any:  
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Full Name of Sixth  
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